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An Ancient Eye Test—Using the Stars

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Abstract. Vision testing in ancient times was as important as it is today. The predominant vision testing in some cultures was the recognition and identification of constellations and celestial bodies of the night sky. A common ancient naked eye test used the double star of the Big Dipper in the constellation Ursa Major or the Big Bear. The second star from the end of the handle of the Big Dipper is an optical double star. The ability to perceive this separation of these two stars, Mizar and Alcor, was considered a test of good vision and was called the "test" or presently the Arab Eye Test. This article is the first report of the correlation of this ancient eye test to the 20/20 line in the current Snellen visual acuity test. This article describes the astronomy, origin, history, and the practicality of this test and how it correlates with the present day Snellen visual acuity test. (**Surv Ophthalmol 53**:536–539, 2008.

Key words. Alcor • Al-Sufi • Arab astronomy • Arab eye test • double stars • Mizar • naked eye star tests • Snellen vision test • vision function • vision star tests • vision testing

Testing for good eyesight was as important in ancient times as it is today. Hunters' and warriors' very survival depended upon keen eyesight. In some cultures, the predominant testing method was the recognition and identification of the constellations and celestial bodies of the night sky.

The Arab Eye Test

A common vision test in ancient Persia used the double star of the Big Dipper in the constellation Ursa Major or the Big Bear. This vision evaluation test was given to elite warriors in the ancient Persian army and was called "the test" or "the riddle."[10] The desert Arabs, especially the Bedouins, used the separation of Mizar and Alcor as a test of good vision.[4] The separation of these two stars is known as the *Arab Eye Test*, and has been used in antiquity to test children's eyesight.[10,20] This article explores the origin, history, and practicality of this eye test and how it correlates with the present-day Snellen visual acuity test.

Mizar–Alcor

The second star from the end of the handle of the Big Dipper is an optical double star. It can best be seen with careful observation on a moonless, clear, cold night away from light pollution.[3,10,18] The Big Dipper or The Plough as it is called in the United Kingdom is in the constellation Ursa Major or the Big Bear (Fig. 1).[5] This constellation has many different interpretations and mythologies in other cultures.[4]

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Fig. 1. Mizar and Alcor, the double star and the handle of the Big Dipper.

The two stars Mizar and Alcor are separated by 12 minutes of arc. They are not, however, side by side. Alcor with a brightness of the 4th magnitude, is many light years farther away from us than Mizar (brightness 2nd magnitude). Alcor, as its name ("the faint or forgotten one") suggests, is considerably dimmer, but then its light has traveled thousands more years to reach the earth.[10] Magnitude of brightness is a reverse logarithmic scale, with each decrease in magnitude number being 2.5 times brighter than the lesser magnitude. These double stars, Mizar and Alcor, are separated by 0.2 degrees.[10] A classic example of 1 degree of separation is seen if you extend your arm out and put your little finger toward the sky, the apparent width of your little finger is equivalent to 1 degree of separation. A degree can be further broken down to 60 minutes; hence, 12 minutes, which is approximately 1/5 of a degree, would be just a slight sliver of your little finger.

Optics

On the Snellen visual acuity chart, the small E on the 20/20 line from the top to the bottom subtends or encloses 5 minutes of arc at 20 feet.[1] This test was refined by Herman Snellen, a Dutch ophthalmologist, in the 1800s. Snellen visual acuity testing has become the most widely used and practical test of visual acuity in the world because it can be standardized and reproduced easily. The E on the 20/20 line, which is 5 minutes of arc, can be further broken down into 1-minute segments (Fig. 2). The top black bar of the E is 1 minute, the white space in between is 1 minute, the next black bar is 1 minute, the next white space is 1 minute, and the bottom black bar is 1 minute for a combined total of 5 minutes. One minute of arc is considered near the limit of resolution for human vision, as proven by Robert Hooke circa 1674.[6,7,8,20] Using only the angle of separation between the two points of light of Mizar and Alcor of 12 minutes of arc would be equivalent to approximately 20/200. Solely based on resolution, 20/200 does not seem to be a good test of vision. Resolution is the ability to resolve minimal

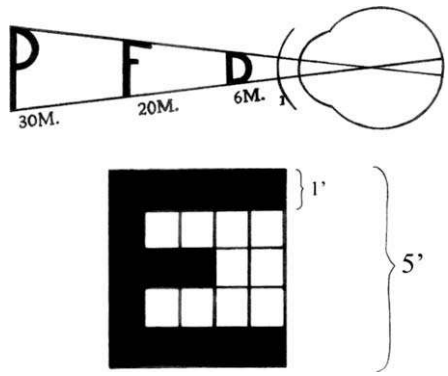

Fig. 2. Snellen chart 20/20 line at 20 feet – the E is 5 minutes top to bottom and each bar is 1 minute.

separate points.[11,12] Visual acuity also depends on brightness, contrast, sharpness and physiological factors. Mizar and, even less so, Alcor are not bright; hence, the ability to detect Mizar and Alcor, given their relative levels of magnitude, is considered a good test of vision. On the Snellen chart the letters are sharp, black on white with good contrast and a bright background. The two separate stars Mizar and Alcor are difficult to see because it is more difficult to see white objects against a black background than black objects against a bright background.[11] The relative unequal intensities of these stars plus contrast, distortion of atmospheric conditions, ambient light pollution, the effects of irradiation of light scatter within the retina, and dark adaptation also reduces the sharpness of the stars. Therefore, detecting both of these stars is considered a good test of vision.

History

An often-misquoted saying of the desert Arabs is the following: "He can see Alcor but cannot see the full moon." This is said of a person who can see trivial details but not the big picture. The history of this test and the correct quote can be found in the original Arabic literature in 900 CE. A prominent Arab astronomer who described this test was al-Sufi, in 964 CE.[2,7,9,10,17,19]

In al-Sufi's book *Description of the 48 Constellations,* also entitled *The Book of Fixed Stars*, of which there are at least six known manuscript copies in the world, Sufi states,

> Above Mizar, there is a very small star that is almost attached to it that the Arabs called Al-Suha. In other Arabic dialects it is called al-Saidaq or Nu'aysh, and was not mentioned by Ptolemy. It is the one with which people test their vision. They say, 'I show him the Suha and he shows me the moon.' It is told that the companions of the prophet used to do that.[2,17]

Al-Suha is also a term for the *forgotten one,* which is the dimmer Alcor. Hence the real quote is not "He can see Alcor but not the full moon," but "I show him Al-Suha and he shows me the moon." One interpretation of this proverb is a person is shown a subtle thing but only sees the obvious, that is, does not grasp the subtlety. The illustration, from the Al-Sufi book, appears to be a tiger (Fig. 3). One can see the double star, the second star at the end of the tail of the animal.

Mizar and Alcor are also known as the "horse and rider" and have been used by cultures other than the Arabs for testing vision.[10,14] The *Official Boy Scout Handbook* of 1954 states that Native Americans tested children's eyesight by using this double star. The brighter star Mizar was called the Squaw and the smaller less bright star Alcor was called the Papoose. However, this statement cannot be documented because much of Native American folklore was passed down in oral history and no written records are available.

Correlation of the Arab Eye Test to the Present Day Snellen Visual Acuity Test

An experiment was constructed to test the correlation between the Arab Eye Test and the present-day Snellen visual acuity testing (Table 1). The author conducted an experiment on a moonless, cold night in the country away from ambient light from cities and towns. Ten volunteers ranging in age from 12 to 49, all whom were corrected to 20/20 or better, were asked to look at this star grouping. All were able to see that there were two stars. Each eye was tested separately, placing increasing increments of plus spheres until the vision blurred enough so that they could no longer distinguish the two separate stars Mizar and Alcor. The amount of spherical power that it took to blur the subject was surprising, ranging from +0.50 to +0.75. No contrast sensitivity testing or measurement of illumination by special instrumentation was done. The next day the same subjects were tested on a standard Snellen visual acuity chart at 20 feet. As noted before, they could see the 20/20 line with ease. Again, increasing plus spheres were placed over each eye separately until they were unable to see the 20/20 line. The average power to blur out was again +0.50 to +0.75. In the majority of the cases this amount not only blurred out the 20/20 line but also dropped the vision to approximately 20/30. Hence, for the 20 eyes tested of the 10 individuals, there was a definite correlation with the amount of blurring of the stars with spheres and the blurring of the Snellen 20/20 line. The conclusion of this test demonstrated that the double star test or this Arab Eye Test was approximately equivalent to the currently used Snellen 20/20 line. This star test correlated the results of two different but related tests. It is of interest that an additional subject who was 65 years old (not reported) and who was correctable to 20/20 could not see the double star. This points to other factors (such as contrast sensitivity) interfering with perception. This may well be due to early nuclear sclerosis or early age-related changes. In practice, some patients can see

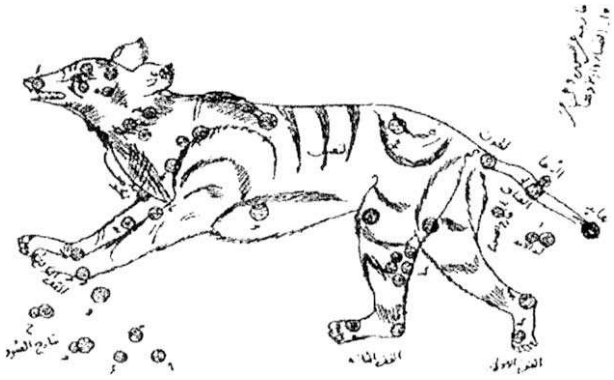

Fig. 3. Representation of animal from al-Sufi's *Description of the 48 Constellations.* [2] Note: Second star from the end of the tail is drawn as two stars, the smaller is Alcor. The Arabic name is Suha ("the forgotten one" or "the rider").

TABLE 1

Amount of Plus Sphere to Blur Out Double Star and Corresponding Snellen 20/20 line

Volunteer		Blurred Stars With Sphere of	Blurred Snellen 20/20 Line With Sphere of
#1	OD	+0.25	+0.50
	OS	+0.50	+0.50
#2	OD	+0.50	+0.50
	OS	+0.50	+0.75
#3	OD	+0.25	+1.00
	OS	+0.25	+1.00
#4	OD	+0.50	+0.75
	OS	+0.50	+0.75
#5	OD	+0.50	+1.00
	OS	+0.50	+1.00
#6	OD	+0.50	+0.75
	OS	+0.50	+0.75
#7	OD	+0.75	+0.75
	OS	+0.50	+0.50
#8	OD	+0.75	+0.75
	OS	+0.50	+0.50
#9	OD	+0.50	+0.50
	OS	+0.50	+0.50
#10	OD	+0.25	+0.50
	OS	+0.50	+0.50

#11 OD Unable to see the double star though corrected to 20/20 Each eye of each volunteer was tested separately using increasing plus spheres over-refraction until they were unable to distinguish the separation of the two stars; Snellen testing using increasing plus spheres over-refraction until they were unable to see the 20/20 line.

20/20 but the quality is poor due to cataracts, mild macular degenerative changes, pupillary membrane, and so forth. The Snellen visual acuity is essentially a quantitative test but not always a useful assessment of qualitative vision. Visual function, rather than visual acuity, has become increasingly accepted as the fundamental basis for deciding when ophthalmic surgery is appropriate.[15] Visual function is difficult to define and measure. Ophthalmic surgeons are faced with the difficulty of making recommendations about procedures that have both medical and legal consequences in the absence of definite criteria for visual function.

Visual Acuity Testing with Other Celestial Objects

Other celestial objects in the past and present have been used to test visual acuity. Examples of these are Venus at various phases; Epsilon Lyra, a double star; and the Pleiades—The Seven Sisters.[3] It is claimed that the sharp vision needed to see these phenomena is approximately 20/15, but this has not been proven experimentally by the author.

Conclusion

The Arab Eye Test using the double star of Mizar and Alcor remains a practical test of visual acuity and visual function as it was over 1000 years ago. This test is somewhat equivalent to the 20/20 in the Snellen visual acuity nomenclature. This is the first report that correlates the Mizar–Alcor naked eye test with the current Snellen visual acuity test. With the spread of Islam from Spain to Central Asia, the Arabs brought their knowledge of astronomy mixed with the traditions of Greece, India, Babylonia, and Persia to Western civilization.[13,16]

Throughout our history the stars have been a constant guide to navigation, measure the seasons, to divine the future, and to measure eyesight. The Arab Eye test is an example of how a natural phenomenon has been used for a practical purpose.

References

1. Adler F: Textbook of Ophthalmology. Seventh Edition. Philadelphia, W.B, Saunders Co, Seventh Edition 1962. 54–7
2. al-Sufi A: Kitab suwar al-kawakib al-thamaniyah wal-al-arba'in [Treatise on the Fixed Stars]. Haydarabad, Osmania Oriental Publications Bureau;p 32, 1954
3. Berman B, et al: Eye See, You See. Astronomy 32:14, 2004
4. Cornelius G, Devereus P: The Secret Language of the Stars and Planets—A Visual Key to the Heavens. San Francisco, CA, Chronicle Books, 1996. pp 108–9
5. Dibon-Smith R: The Constellations Pocket Guide. Toronto, Ontario, 2002. Clear Sky Publishing Companypp 273–6
6. Duane T: Clinical Ophthalmology. Philadelphia, PA, Harper & Row, 1982
7. Hooke R: The Posthumous Works. London, Smith and Walford, 1705
8. Hooke R: Animadversions on the First Part of the Machina Coelestis of the Honorable, Learned and Deservedly Famous Astronomer Johnnes Hevelius, Consul of Dantzick, Together with an Explication of Some Instruments. London: Martyn, 1674, p 8
9. Kunitzsch P: The Arabs and the Stars, Texts and Traditions on the Fixed Stars and Their Influence in Medieval Europe. Northampton, Variorum Reprints;122–4, 1989
10. Moore P: Norton & Co. New York, W.W., Astronomers' Stars, 1982. pp 22–9
11. Rubin M, Walls G: Fundamentals of Visual Sciences. Springfield, MA, Charles C. Thomas, 1969. pp 166–74
12. Runge PE: Eduard Jaeger's test-types (schrift-scalen) and the historical development of vision tests. Trans Am Ophthalmol Soc 98:375–438, 2000
13. Saliba G: Islamic Science and the Making of the European Renaissance. Cambridge, MA, MIT Press, 2007. pp 4–7
14. Serviss G: Astronomy with the Naked Eye. New York, Harpers, 1908. pp 69–71
15. Steinert R: Vision function versus vision testing. Ophthalmology 113:1255–6, 2006
16. Teresi D: Lost Discoveries: The Ancient Roots of Modern Science from Babylonians to the Maya. New York, Simon & Schuster, p 143
17. Upton JM: Metropolitan Museum Studies. Metropolitan Museum of Art 4(180):186–7, 1933
18. Wade N: Image, Eye and Retina. J Opt Soc Am 24:1236–8, 2007
19. Wellesz E: An Islamic Book of Constellations. Oxford, Bodleian Library, Oxford University Press, 1965. pp 3–7
20. Wooldridge M: The Arabic Eye Test, revisited. Br Med J 310: 297, 1995

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